Senior Thesis

Microscopic Study of the Hidden Treasure Ore Body, Rocky Range, Utah

By
Steven V. Mason

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Approved By:

Douglas E. Pride

Douglas E. Pride

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Abstract

The Rocky Range is a small but important mining area located in Beaver County, Utah. Contact replacement skarn deposits of the area have also gone through supergene enrichment during which copper sulfides and oxides have replaced some of the original mineralization.

Introduction

The minerals examined in this study are from an open pit mine located in the Rocky Range, Milford, Beaver County, Utah. To get to the deposit from downtown Milford, take 21 to the northwest of town. After about five mile, you will take a right just before mile marker 73. You follow this dirt road for about two miles staying to the right past the first crossroads then to the left past the other two crossroads. The Hidden Treasure mine is the first pit you come to on the south side of the Rocky Range. To the east about a half mile are what is left of the Old Hickory mine and part of the Montreal mine. If one continues up the road another 2 miles you'll come to another mine called the Copper Ranch mine. Mining history began in the mid 1800's in the Rocky Range but went into heavy production when copper prices jumped in the early

1900's. The raw material was trucked into Milford and hauled by train to Salt Lake City for processing (Whelan 1984). Copper, silver, and tungsten were the primary metals mined out of the area. In the 1920's, magnetite with small amounts of copper was mined for fluxing iron(Whelan 1984).

After about 15 years of inactivity in the area, tungsten was mined from 1941-1943 and 1955-1956. In the early 1960's, the Cerro Verde Mining Company discovered the Bawana (not on the map) ore body that was strip mined until 1969. In 1970, the Shield's Development Company took over the mining and subsequently turned it over to Essex International, Incorporated in 1971. Essex continued mining the OK mine in the Beaver Lake area, and opened the Maria Mine and the Hidden Treasure ore body in the Rocky Range. Mining operations stopped in the fall of 1974 and nothing new has been done since that time. (Whelan 1984)

The purpose of the present study was to look at the mineralization that currently is exposed in the Hidden Treasure mine and determine what mineral phases are present, identify the paragenesic sequences of the minerals, and determine what caused the mineralization. Previous work has been done in the area and contains information on the Beaver Lake District and the Rocky Range, but the studies are lumped together. The Beaver Lake

District is located northwest of the Rocky Range. Butler (1913) published one of the most complete papers on the area followed by Whelan (1982),Erickson and Marranzino (1960) and Connor and Miesch (1963). The late Professor Bronson Stringham of The University of Utah did the mapping contained in the study by Whelan.

Geology

The Rocky Range is a small, isolated mountain range just northwest of Milford, Utah. The mountains rise to nearly 1000 feet above the surrounding desert valley. The mountains take up less then 10 square miles of land and contain a few different sedimentary rock types from marbles to quartzite to metamorphosed shales. The ages of the sedimentary units are Cambrian and Permian to Triassic. Detailed stratigraphic interpretations are not possible because the rocks have been metamorphosed and heated which has destroyed the fossils. The country rock of the Hidden Treasure ore body is limestone that has been metamorphosed to garnet-diopside-magnetite bearing rock.

Field Work

Field work from this study consisted of two trips to the mine. The first stop was in June of 2001 while the researcher was attending The Ohio State University field station in Ephraim, Utah. A general interest in the mine was developed then and samples where returned to The Ohio State University for study. The second visit was to collect additional samples and examine the geology of the Hidden Treasure deposit in detail. Samples of ore were collected at that time as were pieces of the country rock, the contact between the granite and the country rocks, and a piece of a dike that cuts the deposit. Photographs and measurements also were taken at this time and their locations were drawn on the map.

The pit at the Hidden Treasure mine is about 150 meters long, 15-30 meters wide and to a depth of 20 meters. Hand samples of ore contained massive chalcopyrite, bornite, and magnetite, plus chalcocite, covellite, idocrase, malachite, diopside, garnet, calcite, chlorite, and minor scheelite. Chlorite can be seen throughout the samples. Chalcopyrite and bornite occur throughout the mine area. Scheelite is associated with chlorite. Calcite occurs as a secondary mineral in hand samples with chalcocite, hematite, and covellite.

Laboratory work

Twelve samples were selected for microscopic study and sent to Spectrum Petrographics, Inc. of Winston, Or. Standard thin sections were made from the samples and polished thin sections made from the remaining samples. Together the mineralized rocks contained: chalcopyrite, bornite, chalcocite, malachite, covellite, magnetite, hematite, garnet, calcite and diopside where encountered. The primary ore consist of massive chalcopyrite and bornite. Under the microscope, bornite is inclusion free except occasionally near its contact with chalcopyrite (top of page 21). Chalcopyrite generally contains inclusions of bornite and chalocite usually replaces the margins of the chalcopyrite. Chalcopyrite and bornite occasionally exhibit a "eutectic"intergrowth (see page 21) suggesting that they may have been forming at the same time and both are replaced by chalcocite and covellite. Chalcocite attacks and replaces both bornite and chalcopyrite forming a bluish halo around both minerals. In addition, covellite can be seen "eating"away at the chalcocite. Along the surfaces and cracks that where exposed to meteoric fluids. Covellite and chalcocite both appear light gray to blue under incident light, covellite exhibits bright yellow/orange/red

anisotropy under crossed polars (see page 22). The magnetite is mostly massive but subhedral crystals are seen.

Magnetite occurs in two forms; one that is clean and bright white/gray in color under plane polarized light and as a second form that exhibits martitization texture which is magnetite oxidized to hematite along (111) crystallographic planes (seen on page 24). Hematite is white but exhibits bright orange/red internal reflections under crossed polars (see page 25). Small blebs of chalcopyrite were seen in some of the massive magnetite (top of page 26).

The gangue material in the Hidden Treasure deposit is diopside, garnet, and calcite. Small blebs of chalcopyrite and bornite are present within garnet crystals. The garnet can be identified by its crystal shape and isotropic nature. Calcite is easily identified by the very high order interference colors and twinning (page 26). Diopside is identified by cleavage, its high second order colors and high relief in plane polarized light. The country rock from the Hidden Treasure deposit is a metamorphosed limestone that contains small quartz grains with inclusions of an opaque mineral. Rocks of the Hidden Treasure mine are cut by a late dike that is a dark brown andesite. The Hidden

Treasure mine was generated when a limestone was intruded by a pink to purple granite containing K-feldspar, biotite, quartz, hornblende.

Interpretations and conclusion

The Hidden Treasure ore body is a skarn deposit that has undergone supergene enrichment. The mineralization from the intrusion is diopside, garnet, magnetite, and idocrase. Hematite formed in the zone of oxidation. The original mineralization (see paragenetic diagram) was chalcopyrite and bornite, which have been replaced by chalcocite, covellite, malachite and chlorite when meteoric water percolated down through the original sulfide matrix. At the zone of enrichment, bornite, chalcocite, chalcopyrite, covellite, and the chlorite were concentrated. Chalcocite replaces chalcopyrite, which in turn was replaced by secondary calcite and covellite. The chalcocite also replaced bornite but not as aggressively as it attacked the chalcopyrite. Throughout the deposit, magnetite oxidized to hematite.

References

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Appendix

All pictures where taken at .6 cal time on T160 film at 200X magnification. See figure for location of samples.

MU-001

The slide contains Chalcopyrite (40%), Bornite (40%), garnet (20%), chalcocite (1%), and trace malachite. The bornite is clean of other minerals except along the margins. The margins contain small blebs of chalcopyrite. Bornite can be seen all through the chalcopyrite, but the contact between the bornite and the chalcopyrite is sharp for the most part. Around the bornite and chalcopyrite is a zone of chalcocite replacing both minerals. Covellite seems to be replacing the chalcocite in spots, and trace malachite is seen in the cracks. The gangue is diopside.

Mu-002

The sample contains chalcopyrite (60%), bornite (5%), chalcocite (2%), covellite (1%), trace magnetite, diopside (32%) and garnet. The slide contains mostly fractured chalcopyrite with chalcocite and covellite replacing the

chalcopyrite. The gangue is diopside and possibly some clay material.

MU-004

The slide contains chalcopyrite (35%), bornite (3%), chalcocite (1%), covellite (1%), diopside (60%), and trace malachite. There is two phases to the chalcopyrite that can be seen. Chalcocite is replacing the bornite and chalcopyrite in the cracks and along the edges between the gangue and the ore. The gangue is diopside.

MU-005

The slide contains magnetite (20%), hematite (3%), and calcite (77%). The magnetite shows martitization texture with the hematite along the (111) cleavage planes. The hematite has strong red/orange internal reflections. The calcite shows the high order colors.

MU-C06

Contact between granite and country rock. Large phenocryst of feldspar, quartz, and amphibole.

MU-C07

Carbonate (75%) country rock with small silica grains (25%) and possible trace diopside. Calcite shows high order colors and quartz can be identified by its extinction. The quartz contains an opaque mineral probably an amphibole.

MU-008

The slide contains chalcopyrite (3%), bornite (2%), magnetite (10%), and calcite and diopside gangue (85%). Massive to subhedral magnetite without hematite separate from the rest of the ore.

MU-009

The slide contains massive magnetite (95%), trace chlorite, and trace calcite

MU-D10

Andesite dike that was quick cooled, has a very fine grained ground mass of feldspars.

MU-011

The slide contains chalcopyrite (40%), chalocite (50%), covellite (2%), and calcite (8%). The chalcopyrite is being replaced by the chalocite and some grains are

completely replaced. The calcite is replacing the chalocite and along the outer edge is covellite. The cracks are filled in with calcite.

MU-G12

Granite intrusion contains phenocryst of quartz, feldspars, and amphibole.

MU-013

The slide contains magnetite (25%), hematite (2%) bornite (20%), chalcopyrite (10%), trace malachite, chalocite (2%), trace covellite, and gangue(41%). The magnetite is massive to subhedral and shows martitization near the gangue. The gangue is diopside and calcite. The chalcocite is replacing the chalcopyrite and the covellite is replacing the chalcocite.

Paragenesis

Diopside _____

Garnet _____

Magnetite _____

Chalcopyrite __ _____

Bornite _____

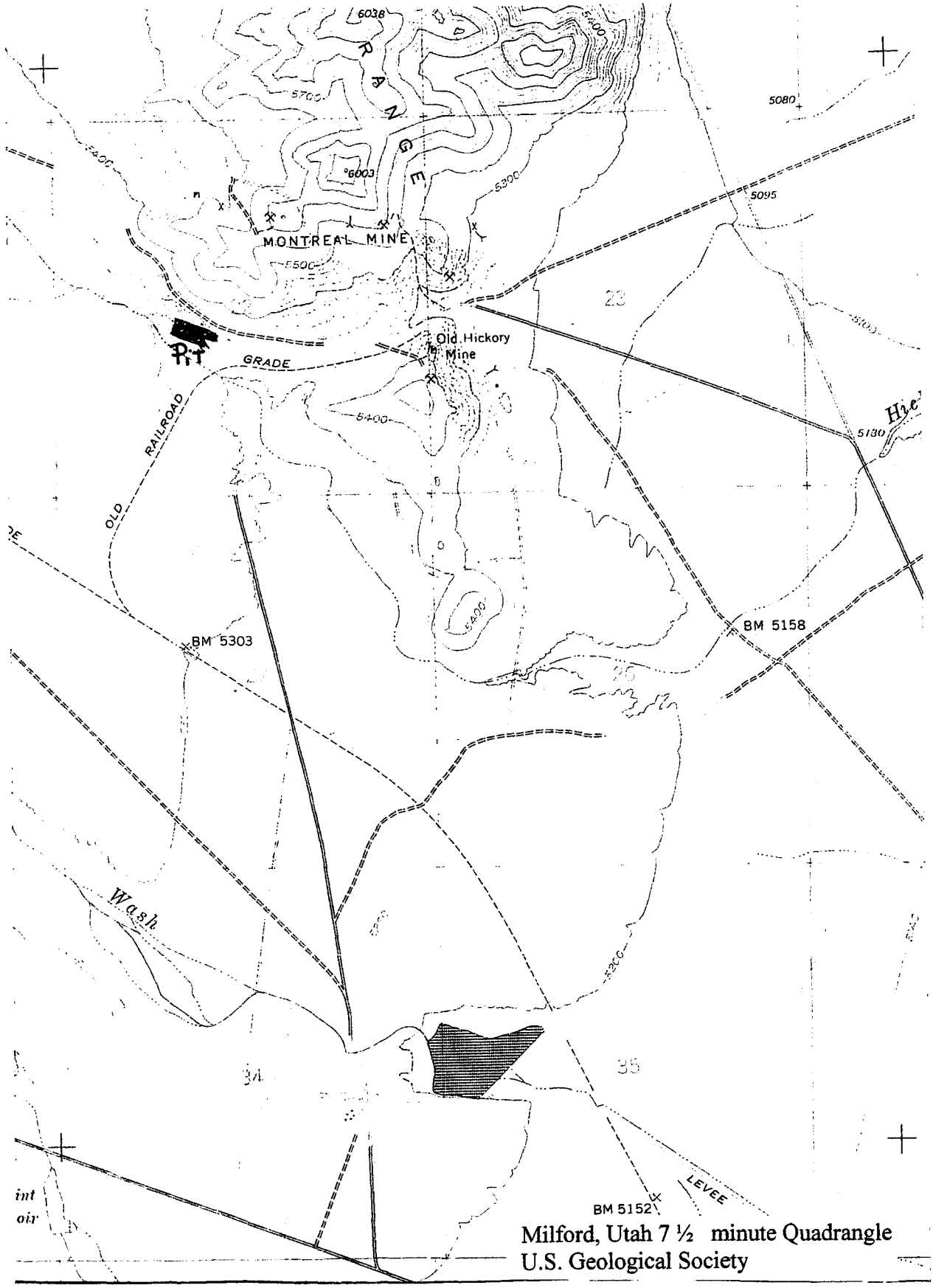
Chalcocite _____

Covellite ___

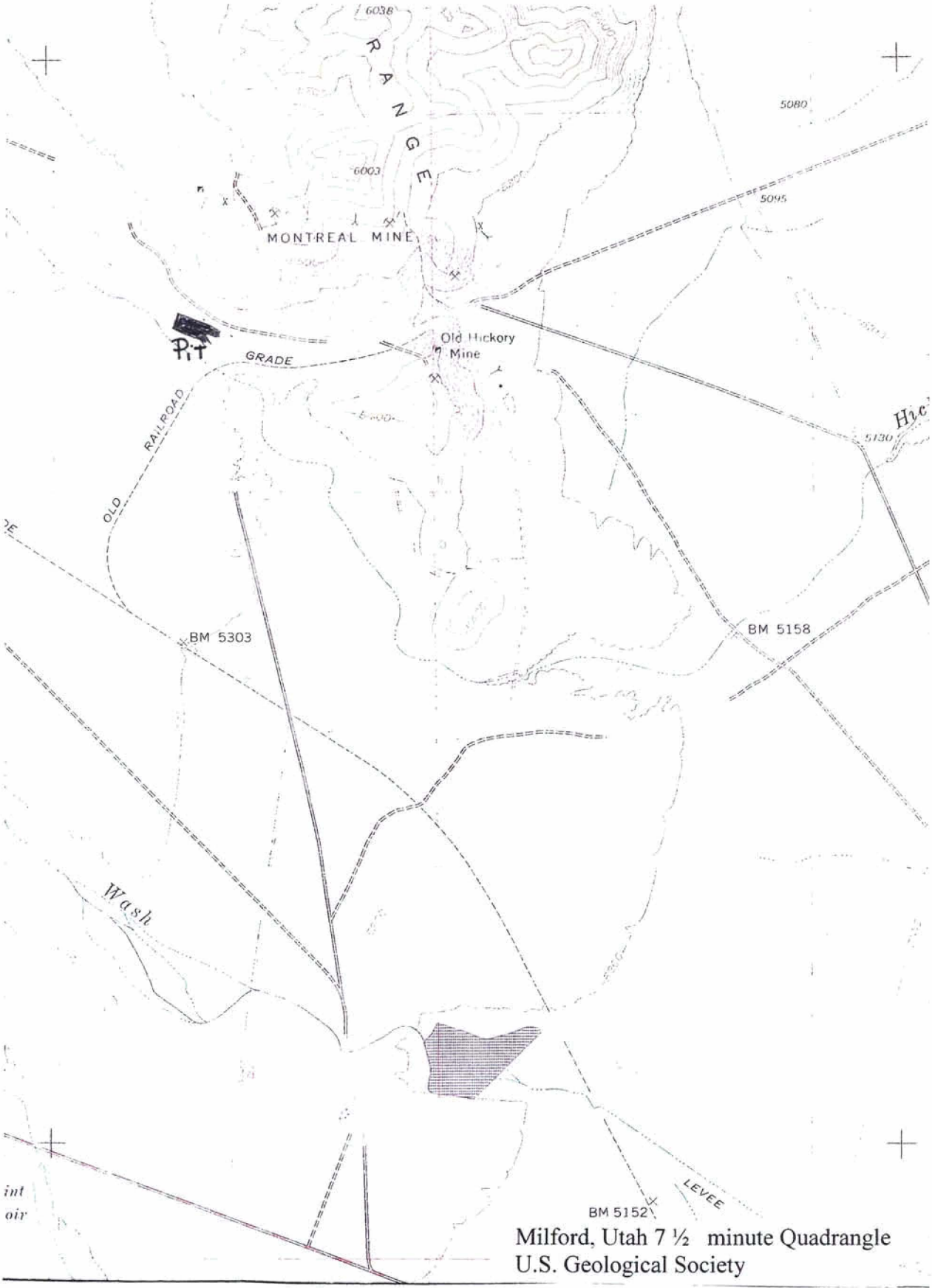
Hematite ___

Malachite __

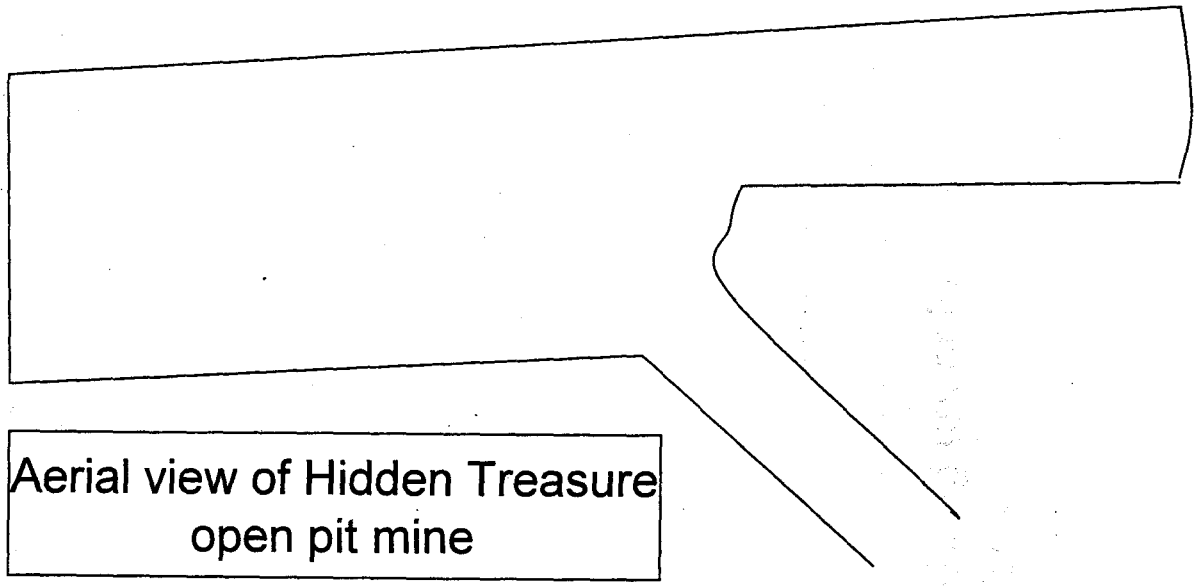
Calcite __



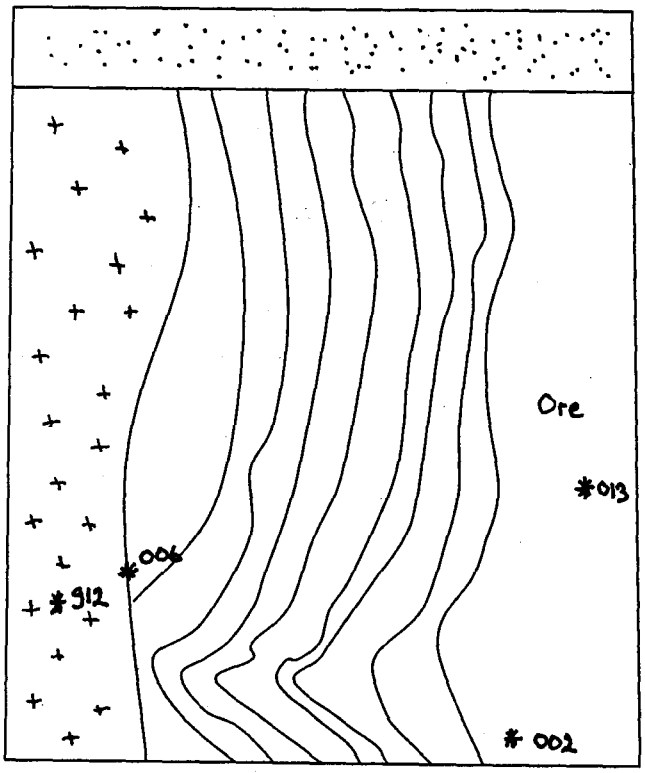
Milford, Utah 7 ½ minute Quadrangle
U.S. Geological Society



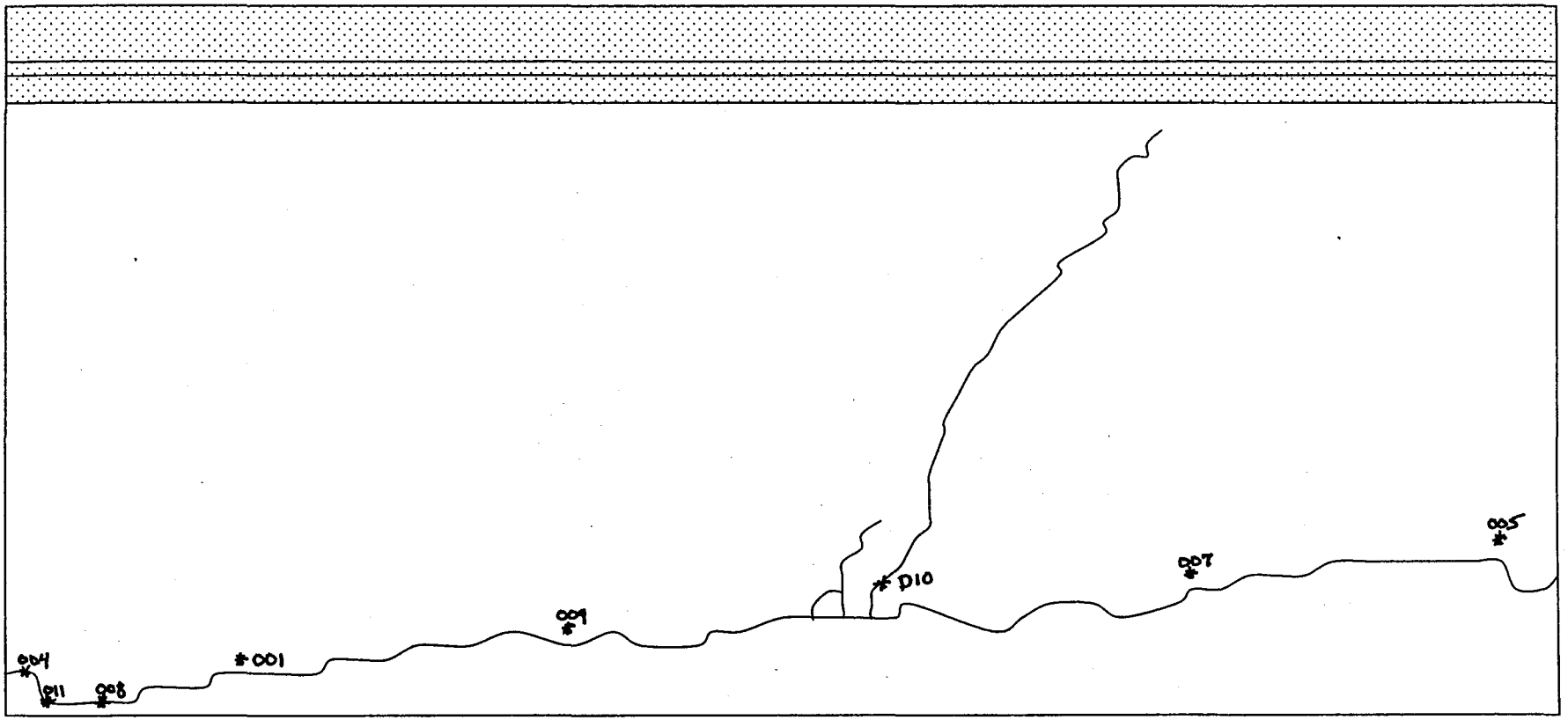
Milford, Utah 7 ½ minute Quadrangle
U.S. Geological Society



Aerial view of Hidden Treasure open pit mine

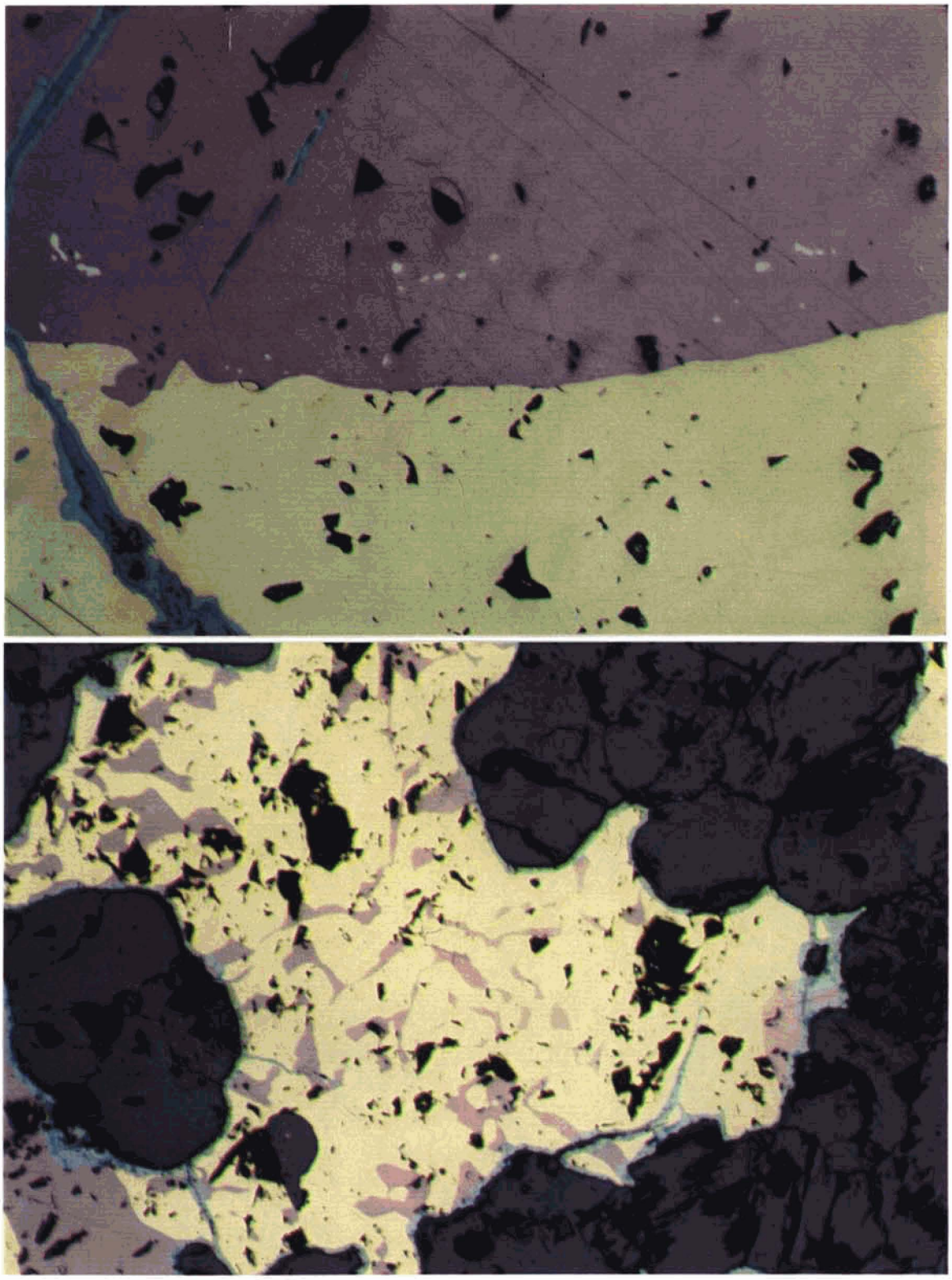


East wall of mine showing sample locations

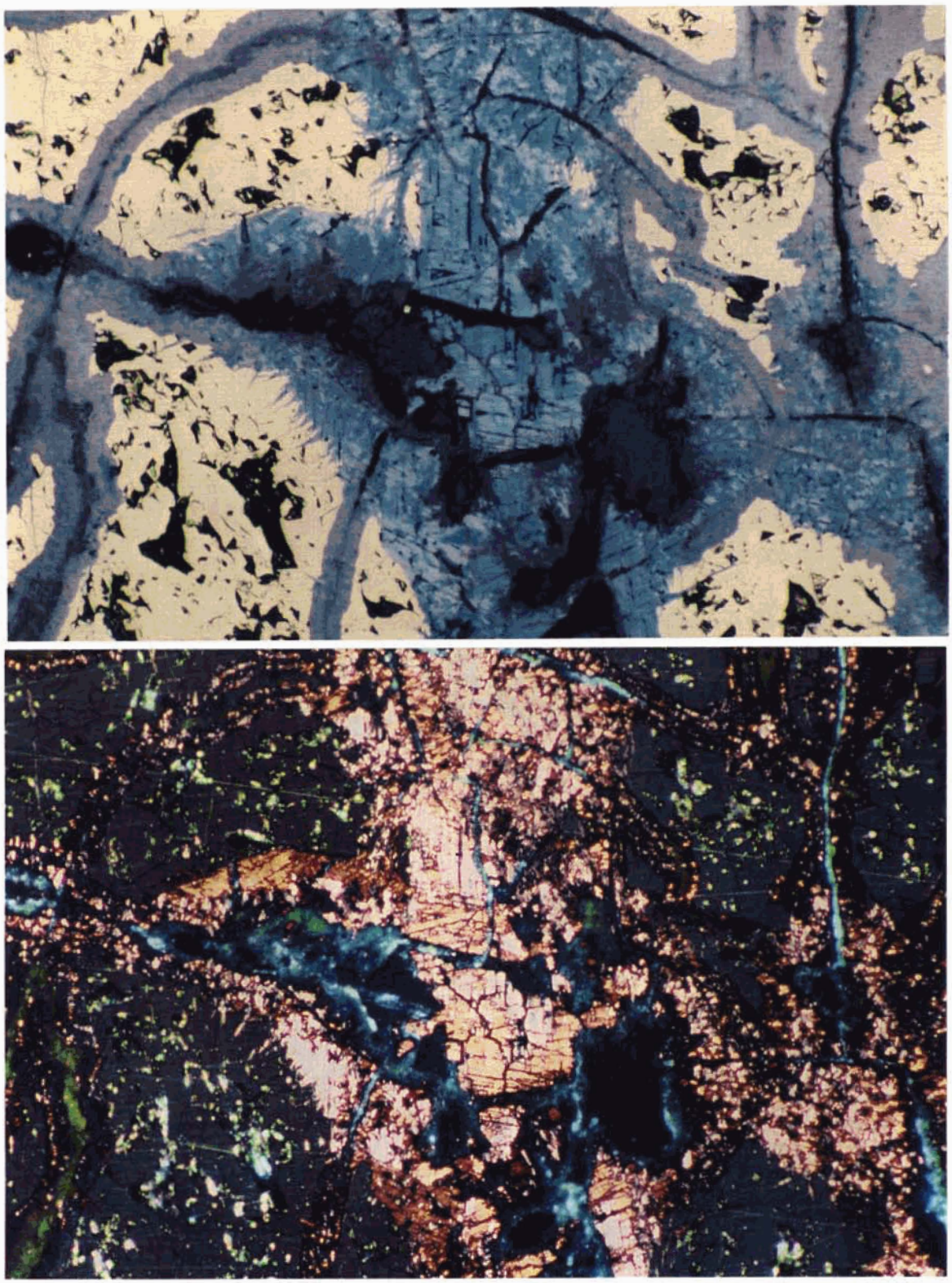


North wall of the Hidden Treasure open pit mine showing unconformity close to top, dike and sample locations

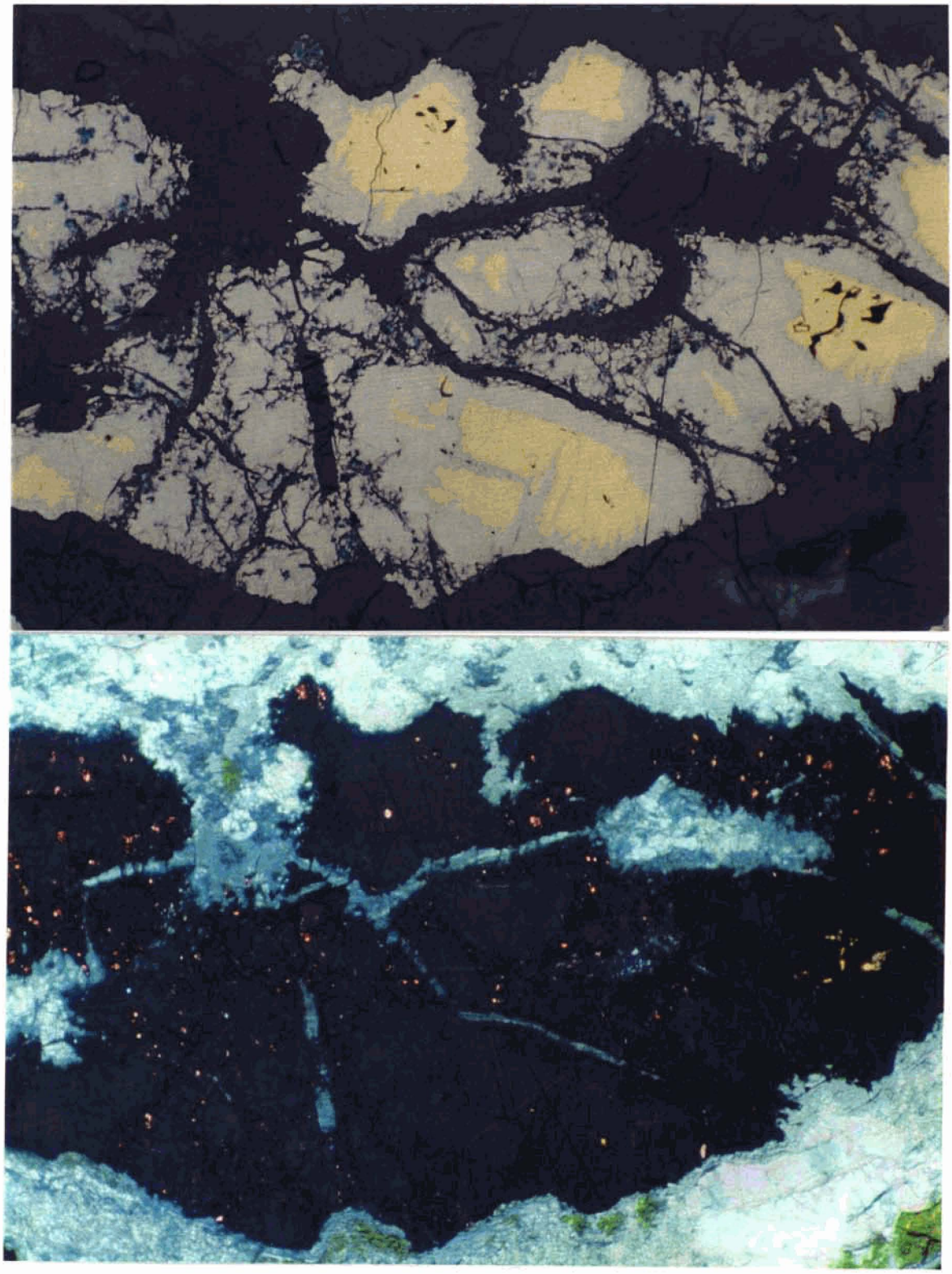
Top- East wall of pit
Bottom- North wall of pit



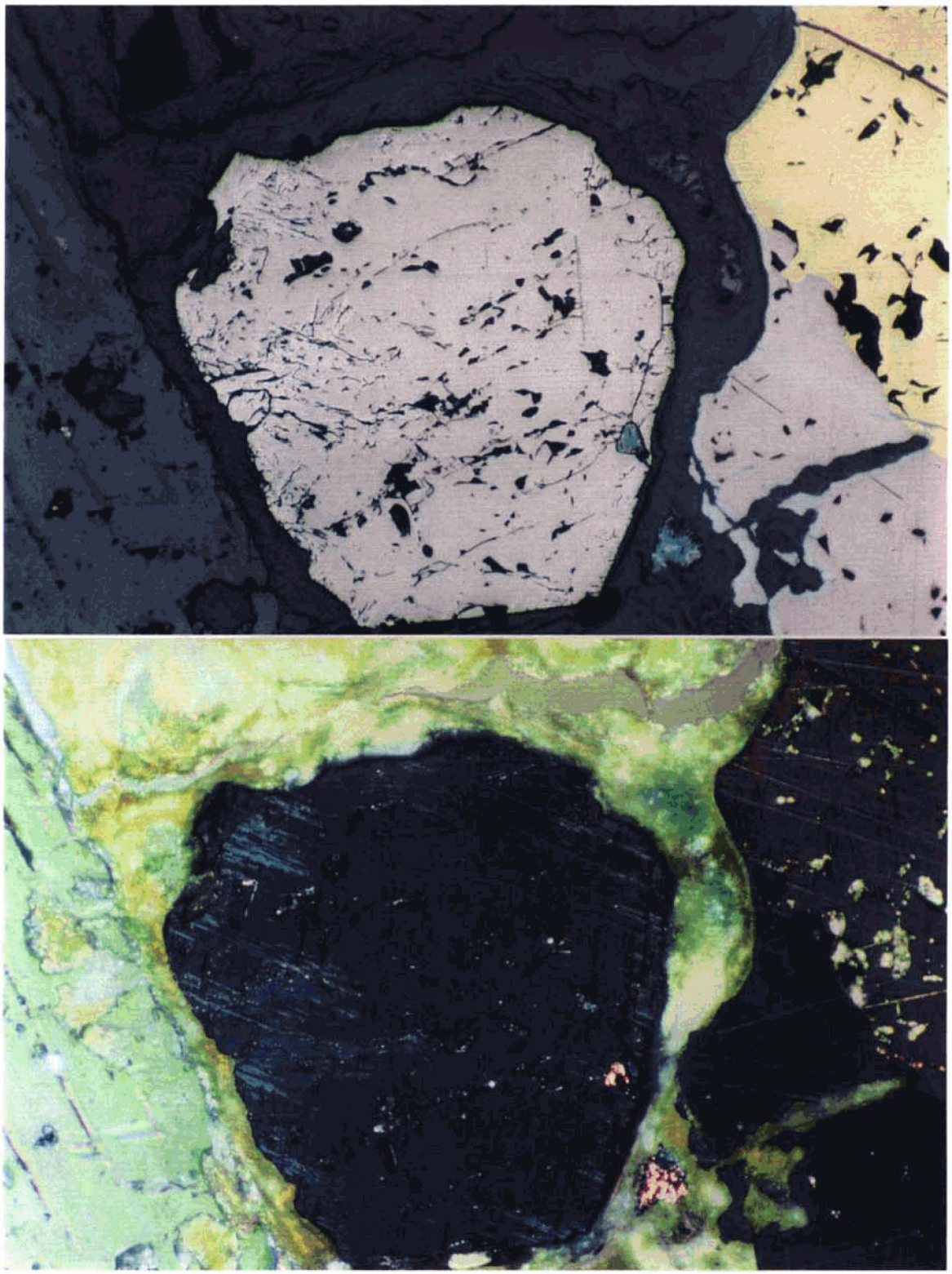
Top- Bornite(purple) with chalcopyrite(yellow) blebs (Mu-001)
Bottom- Mottled texture of chalcopyrite and bornite. Diopside gangue (Mu-004)



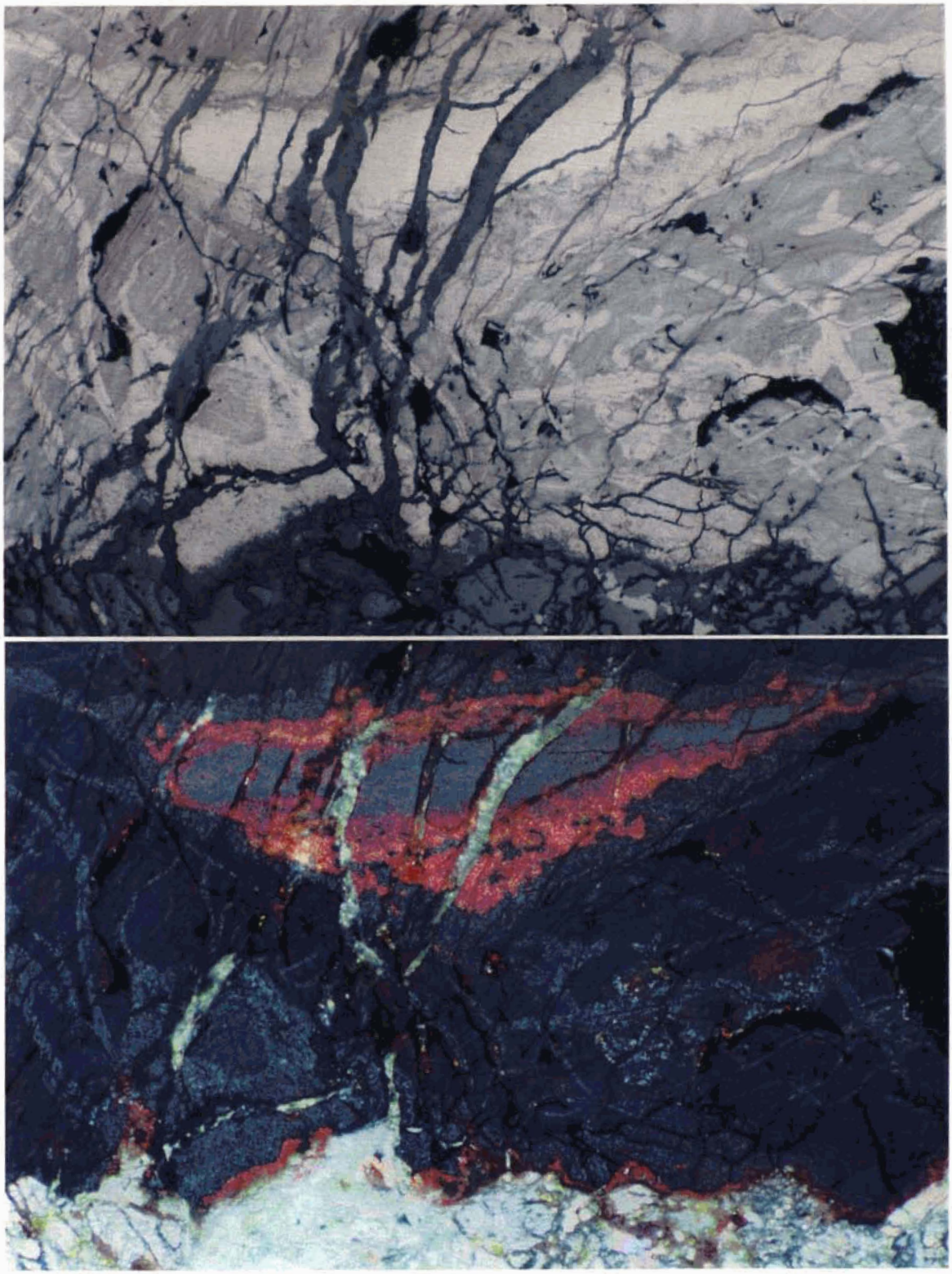
Top- chalcopyrite(yellow), covellite(blue), gangue and malachite(gray) (Mu-013)
Bottom- Polarizars in: covellite(orange) and malachite(greenish)



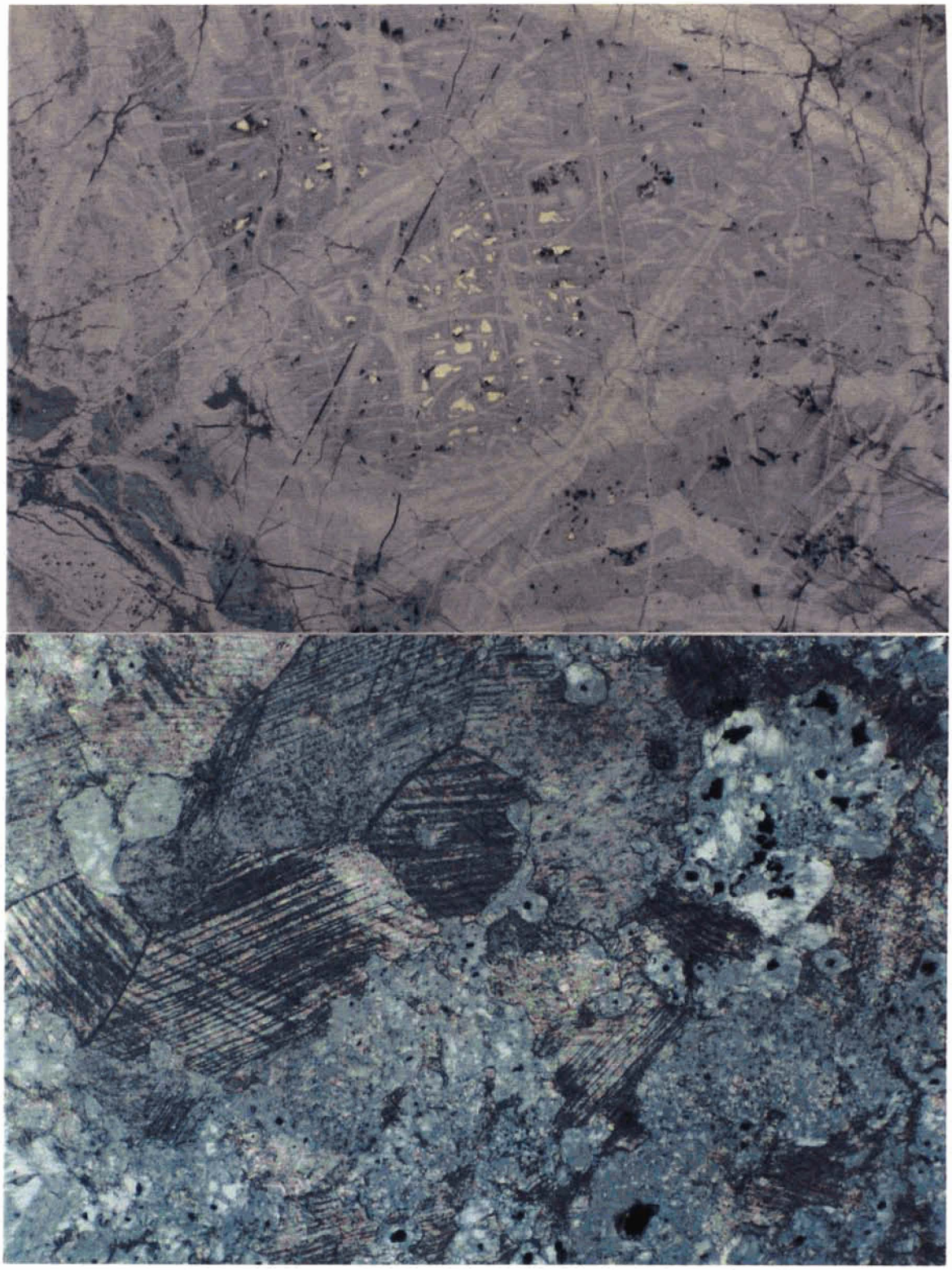
Top- chalcopyrite(yellow), chalocite(blue/gray), covellite(blue), and gangue(dark gray) (Mu-011)
Bottom- covellite(orange), malachite(green), and gangue(white)



Top- Magnetite(white), chalcopyrite(yellow), bornite(purple), diopside(gray) gangue, chalcocite(blue/gray), and covellite(blue) (Mu-013)
Bottom- malachite(green), magnetite with hematite exsolution(black and white), covellite(orange)



Top- Magnetite(gray), hematite(white) and gangue(dark gray)(Mu-005)
Bottom- Internal reflections of hematite



Top- magnetite(gray), hematite(white), and chalcopyrite(yellow) (Mu-013)
Bottom- Country rock showing carbonate(high order colors) and quartz(gray) with black opaque minerals (Mu-c07)